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(54) Display device

(57) A display device, replacing a cathode ray tube, has a scanned light source such as a laser 3 projecting an image onto an image intensifying screen 1 for example a channel plate multiplier. Beam indexing (tracking areas 5 and sensor 4) may be provided to permit registration with colour phosphor stripes (inset) of the screen and/or for distortion correction.

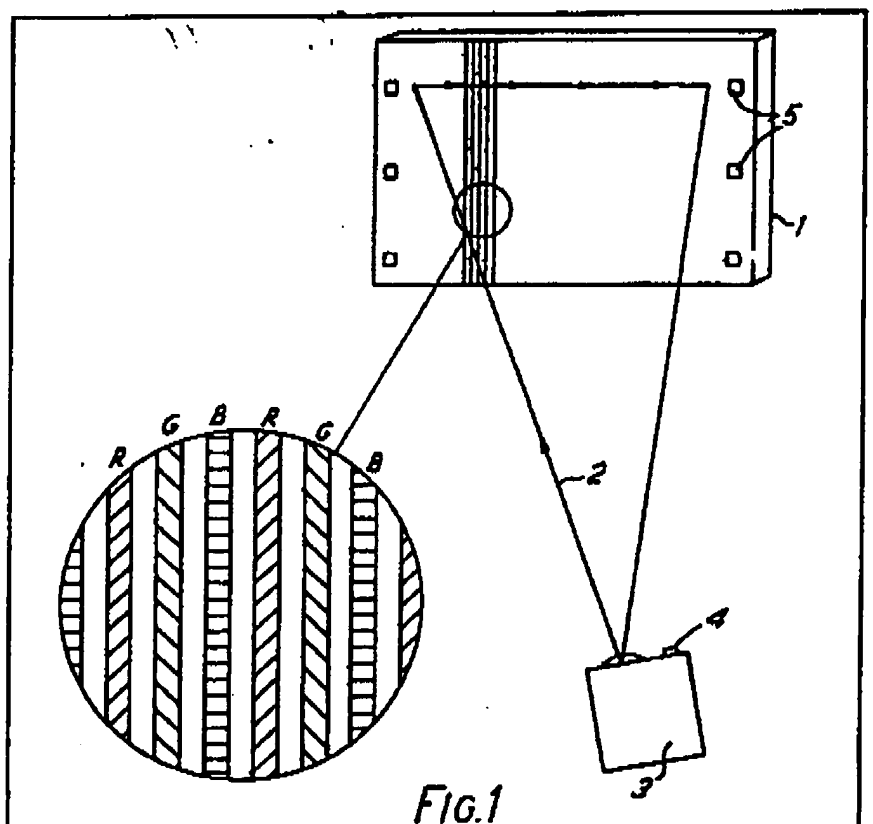

FIG.1

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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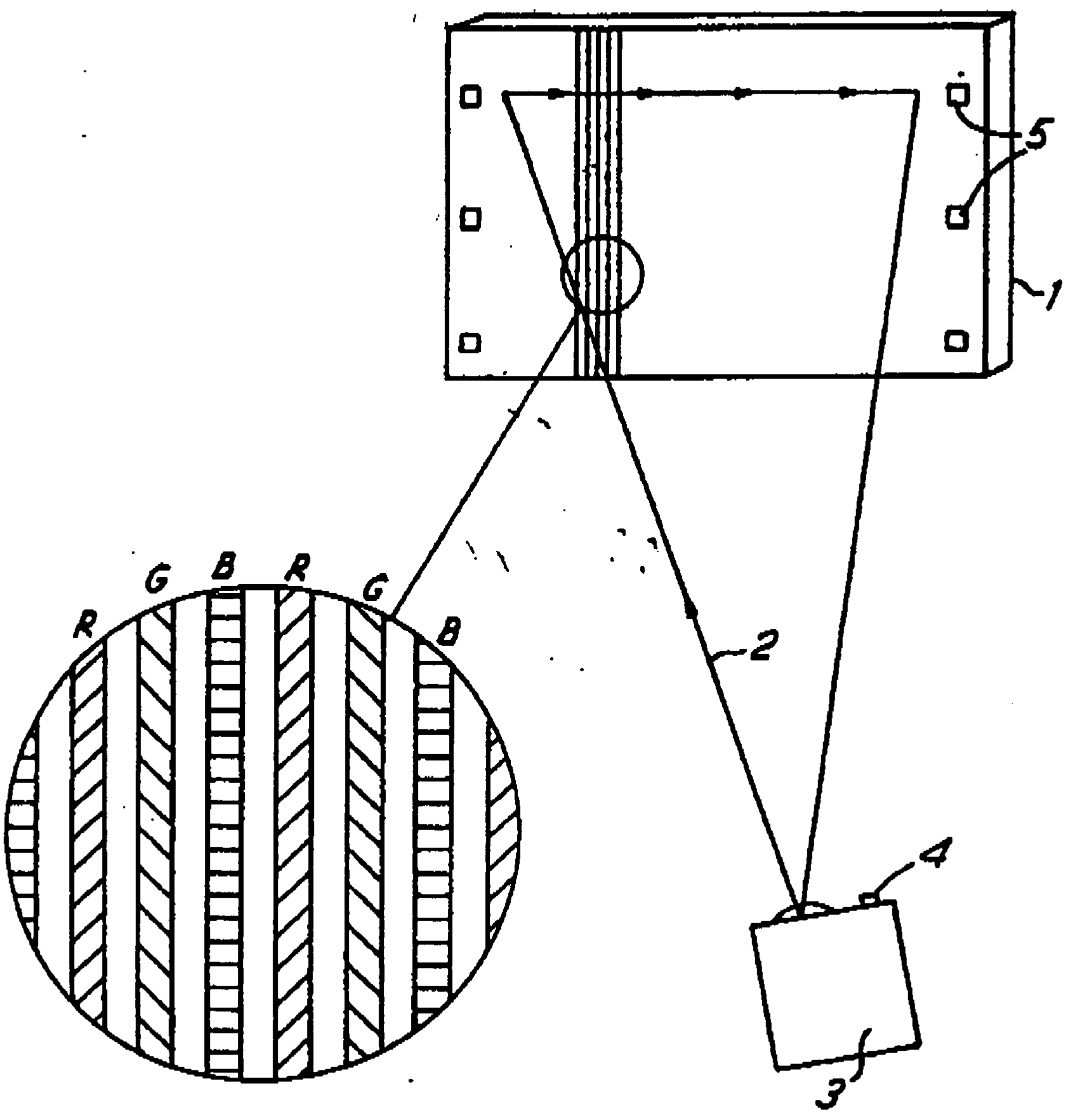

FIG.1

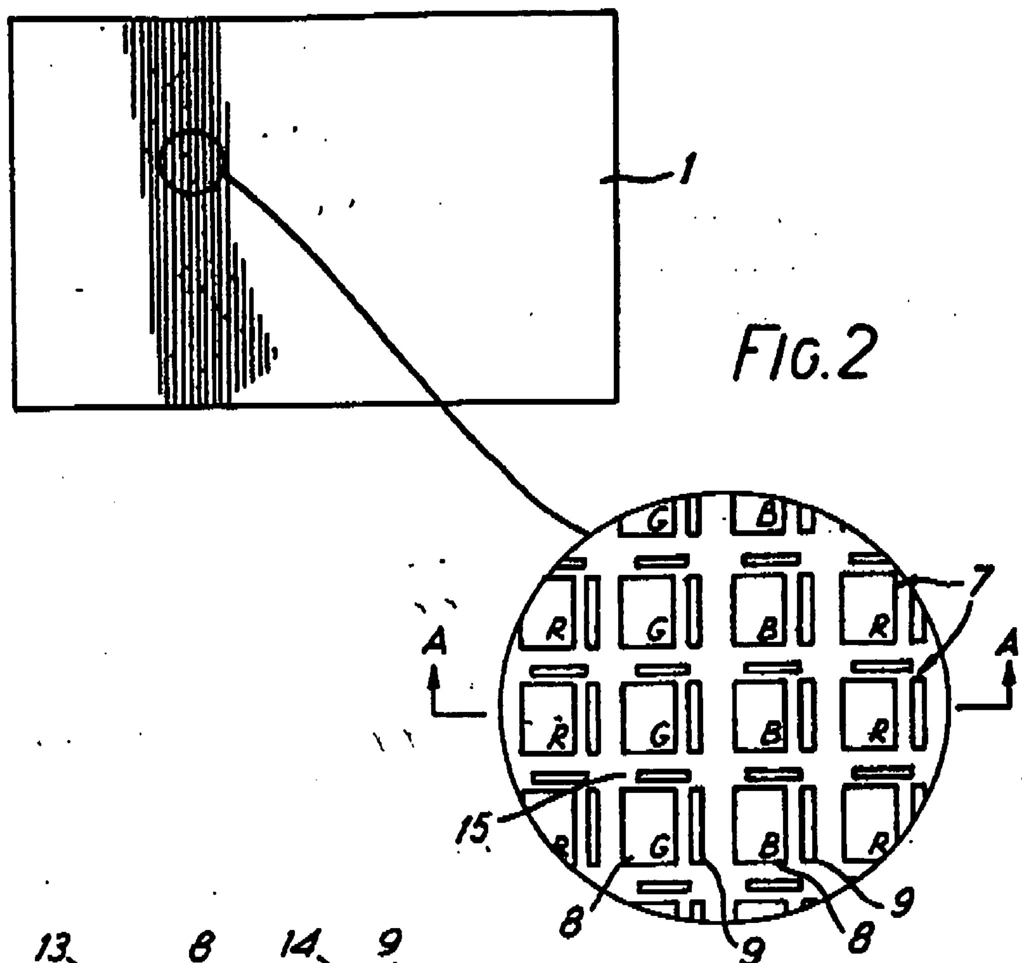

FIG.2

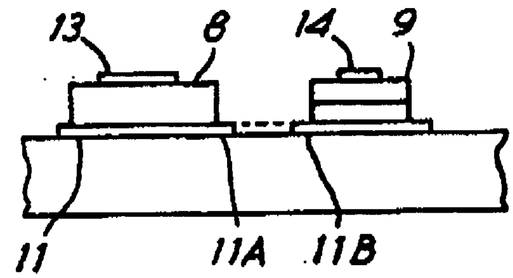

FIG.3

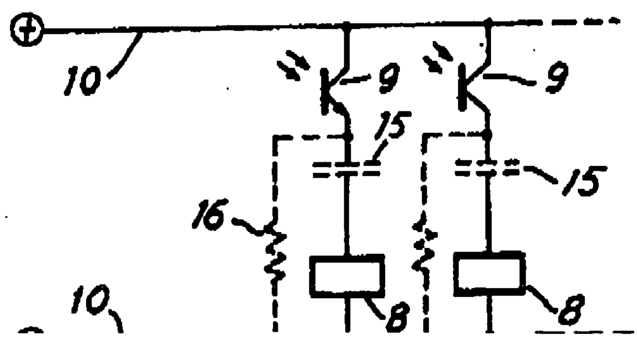

FIG.4

SPECIFICATION
Display device

One of the reasons why the cathode ray tube has, for many applications, reigned supreme as a display device is that the electron beam is an unsurpassed means of addressing a large area with precision, speed and a high dynamic range. It suffers however from the disadvantage that an evacuated envelope of relatively large volume is required. A scanned laser beam or other light source illuminating a screen has many of the advantages of the electron beam but it is not possible with present techniques to obtain sufficient energy in the beam to provide both the addressing function and adequate illumination to give a large, bright display: even if this were possible, there could be a health hazard, particularly in the event of failure of the scanning mechanism independently of the light source.

According to the present invention, there is provided a display device comprising a light source for producing and deflecting a light beam, and an image intensifying screen. In this way, the functions of addressing and providing energy for illumination are separated, the energy for illumination being provided by the active screen with the position and, if necessary, intensity of the illumination being commanded by the light source.

The light source is preferably a laser, although other possibilities exist; for example it could be a cathode ray tube (where the intensity requirement would be much less than is required in conventional CRT projection systems). The wavelength of light emitted can be chosen to suit the image intensifier used. It may be visible light, but this is not essential, indeed, ultra-violet may be preferred as making the fewest demands on the light-intensifying mechanism of the screen.

This invention is of particular interest for raster-scan display systems such as television, for which the light source will require appropriate scanning means and intensity modulation, although it has other applications, for example as an oscillograph.

Arrangements for scanning with light or laser beams, such as oscillating mirrors or electro-optical or acoustic means are of course well known. A suitable device for converting a weak photon signal into a strong photon signal of corresponding intensity is the channel plate: see for example A J Guest "Channel Multiplier Plates for Image Intensification", Mullard Technical Communications, No 108, pp 170—176, November 1970. This is a device which can be used in a flat format to provide a suitable image intensifying screen for the present invention. Alternatively, a semiconductor image-intensifying screen may be used.

Some embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of one form of display device according to the present invention;

Figure 2 shows an alternative screen for use in the display device of figure 1;

Figure 3 is a cross-section on line A—A of figure 2; and

Figure 4 is a circuit diagram illustrating the operation of the screen of figure 2.

Figure 1 shows a raster scan display device for colour television in the form of a back projection arrangement. The screen 1 is a large, flat channel plate multiplier arrangement with, on its front, viewing face, a repetitive pattern of RGB phosphor areas as indicated inset, addressed (on its rear face) by a scanning beam 2 from a laser source 3. The laser source 3 incorporates scanning arrangements for line and field deflection, and intensity modulation for the application of a video signal.

Colour registration is provided by a beam indexing arrangement in which a sensor 4, located adjacent the source 3, tracks the position of the beam in relation to the colour pattern by sensing the nature of signals from the screen, to control the switching of the three colour video signals to the laser.

The tracking signals could be visible or non visible signals reflected or emitted from the screen; in the case of front projection they could be the resultant (intensified) display light itself and/or non-visible signals (e.g. infrared) emitted from special tracking areas.

Such signals could also be used to apply corrections for non-boresight location of the light source 3. This correction could be assisted by the provision of tracking areas 5 at the edge of the screen emitting non-visible signals to the sensor 4 when addressed by the beam.

For a more compact arrangement (in the case of back projection) the laser source 3 can preferably be located to direct light, with or without the aid of mirrors. Here, the beam indexing may be utilised to facilitate correction of trapezoidal distortion ("keystone effect").

Accidental activation of the screen by ambient light can be avoided by a.c. coupling between the laser light beam and the activation of the screen. Thus the laser beam could be amplitude modulated at RF, with a sufficiently high frequency to ensure several cycles per picture element, the image intensifier being designed to respond only to the alternating component of light incident upon it.

As mentioned briefly above, front projection is also envisaged, for example with the light source taking the form of a small projector located near the ceiling in an opposite corner of the room in which the screen in located. This would require a modified screen arrangement. If the image intensifier is fabricated by the assembly of a series of plates stacked together, it should be possible by a combination of chemoforming or integrated optics to achieve addressing and the emission of light from the same surface. Although the screen might consist of an assembly of over a thousand such plates, this is comparable with th

complexity proposed for some flat-screen devices currently under consideration.

Figures 2, 3 and illustrate the construction of a semiconductor image intensifying screen 1 for use in the display device. The screen comprises a flat plate which has on it an array of cells 7 each of which produces a light output in response to the incident radiation. Each "pixel" of the display image is represented by one such cell (for monochrome) or, for colour, three cells; red, green and blue. These are identified in the enlarged portion of figure 2 by the letters R, G, B. The arrangement shown, where the cells of a given colour run in vertical lines on a rectangular matrix, is only one of many possible configurations. The cell density will of course be chosen to provide the definition required from the display.

Each cell has an electroluminescent emitter 8 of appropriate colour and a photodiode or, as shown, a photo-transistor 9, in thin film form. As indicated schematically in the circuit diagram of figure 4, the emitter 8 and phototransistor 9 are connected in series across common power supply rails 10, so that the phototransistor, 9 rendered conductive in proportion to the incident radiation, allows in appropriate current to pass through the electroluminescent emitter 8. The sectional view of figure 3 shows evaporated electrodes; an interconnecting electrode 11 deposited on a substrate 12 and electrodes 13, 14 connecting the emitter 8 and transistor 9 to the positive and negative supply rails 10 (not shown in figures 2 and 3). Transparent electrodes can be used where necessary: if the screen is to be addressed (or viewed) from the rear, both the substrate and the electrode 11 will need to be transparent.

As mentioned above, a.c. coupling is desirable to avoid activation of the screen by ambient light. Thus, each cell may also incorporate a thin film coupling capacitor 15; the interconnecting electrode 11 being divided into two electrodes 11A, 11B. the capacitor is not visible in figure 4, but would typically be formed by a layer of silicon dioxide between overlapping portions of the electrodes 11A, 11B. A d.c. return path for the transistor 9 can be provided by a thin-film resistor (16 in figure 4) formed between the electrode 11A and the negative supply rail. The capacitor could alternatively be interposed at the negative end of the emitter 8 (i.e. between the electrode 13 and the negative power rail); with a single electrode 11.

The described arrangements uses a scanned and modulated laser or collimated light beam to address a large area image intensifier such as a channel electron plate multiplier or semiconductor screen to separate the function of addressing from the provision of energy in the display device. This avoids the need for a scanned electron beam with the added difficulty of providing an unobstructed volume of vacuum or the need for excessively high energy densities in the scanned light beam.

CLAIMS

1. A display device comprising a light source for producing and deflecting a light beam, and an image intensifying screen.

2. A display device according to claim 1 in which the light source comprises a laser and deflection means therefor.

3. A display device according to claim 1 or 2 in which for display of television pictures the light source includes raster scan means and intensity modulation means.

4. A display device according to claim 1, 2 or 3 in which the light source produces an ultra-violet beam.

5. A display device according to any one of claims 1 to 4 in which the screen is a channel plate multiplier.

6. A display device according to claim 5 in which the screen comprises red, green and blue phosphor areas, beam indexing means being provided to control the switching of colour video signals to the light source.

7. A display device according to any one of claims 1 to 4 in which the screen comprises a plurality of cells each with an electroluminescent emitter and a respective semiconductor photosensitive device arranged to control the light output of the emitter.

8. A display device according to claim 7 in which the screen has an array of cells with red, green and blue electroluminescent emitters, beam indexing means being provided to control the switching of colour video signals to the light source.

9. A display device according to any one of the preceding claims, in which the light source is located at a position offset from the normal to the screen, the or a beam indexing means being arranged to control the deflection of the light beam so as to compensate distortion.

10. A display device according to claim 6, 8 or 9 in which the beam indexing means includes tracking areas to reflect or emit indexing signals to a sensor located adjacent the light source.

11. A display device according to claim 10 in which the indexing signals are of infra-red radiation.

12. A display device according to any one of the preceding claims, in which the screen includes a.c. coupling means whereby it is responsive to only the alternating component of the light falling upon it.

13. A display device substantially as hereinbefore described with reference to the accompanying drawings.

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